Growing the
Transplant Onion Crop

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GROWING large onions from transplants has been practiced by many growers in the South and Southwest since the beginning of the industry. Transplant crops are grown on about one-third of the total acreage of onions in the United States. Growers may raise their own transplants, or seedlings; or they may buy them from those who produce them for shipment.

By growing onions in a nursery a large number can be raised in a small space. Home gardeners in most parts of the United States find the use of transplants the most satisfactory method of growing the mild varieties such as the Sweet Spanish and the Bermudas. The growing of seedlings in the South for shipping north in early spring has become an important industry.

The grower should select varieties that bulb well at the temperatures and day lengths of the locality. Varieties that bolt readily should be avoided.

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GROWING THE TRANSPLANT ONION CROP [1]

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Contents

GROWING onions by the transplant method consists in starting the plants in seedbeds and in setting them in the field when they are large enough. On about one-third of the onion acreage in the United States this method is now used.

In the South and Southwest the seed is usually sown in open beds in late summer or early fall. Then the seedlings are large enough for transplanting in late fall or early winter. In the North, however, the seed is sown during February or March in coldframes, hotbeds, or greenhouses. As soon as the weather is warm enough the plants are set in the field. Some northern growers purchase southern-grown transplants.

In the South and Southwest both commercial growers and home gardeners use the transplant method more extensively than elsewhere. In the North, however, commercial growers rarely use it, but home gardeners do to a considerable extent.

The transplants are not susceptible to smut; and in the North the bulbs usually mature early enough to escape severe injury from thrips.

AREAS PRODUCING THE TRANSPLANT CROP

The States chiefly concerned in growing the commercial transplant onion crop are Texas, Louisiana, and California. In Texas it is grown primarily in the irrigated Laredo and Winter Garden districts in the southern part of the State. The Laredo district extends as a narrow strip along the Rio Grande in Webb and Zapata Counties; the Winter

[1] Original version of this bulletin was written by H. A. Jones, L. R. Hawthorn, and G. N. Davis.

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Garden district includes Zavala, Maverick, Dimmit, La Salle, and Frio Counties, as well as contiguous ones. In north Texas transplanting without irrigation is practiced around Farmersville, Collin County. Most of the commercial crop of onions in Louisiana is grown in the southern part of the State in the Lafourche and Pointe Coupee-St. Landry districts. In California the early transplant crop is grown chiefly in the upper San Joaquin and Coachella Valleys, while most of the intermediate crop is grown in the Delta district (the lower Sacramento and San Joaquin Valleys) and to some extent along the coast south of San Francisco.

SOIL REQUIREMENTS

In Texas onions are grown on soils of various types but they are particularly adapted to sandy, silty, and certain clay loams. Many of the sandy loams in the irrigated districts of southwest Texas are fairly shallow and underlain by a rather impervious clay, making them ideal for the irrigation of a shallow-rooted crop like onions, as leaching of fertilizer materials is kept to a minimum. The heavier loams require less fertilizer for the production of a good onion crop, but because these soils dry out more slowly some difficulty may be experienced at harvesttime. Other conditions being equal, onions will usually mature earlier on the lighter soils than on the heavier and darker silt and clay loams. Onions growing on the lighter soils seem to have more pink root, probably because of higher soil temperatures.

In Louisiana the onions are usually planted on the lighter alluvial soils.

In California the early crop is grown on a variety of mineral soils, but part of the intermediate crop is grown on the peat and muck soils of the Delta district.

The onion thrives well on slightly acid soil (pH 6 to 6.5), but it grows poorly on very acid soil. To very acid soil a ton of hydrated lime should be added per acre each year until the acidity of the topsoil is sufficiently reduced. Most of the irrigated soils are alkaline in reaction and do not require liming.

Soils for onions should be retentive of moisture, but they should be well drained. Waterlogged soils should be avoided.

FERTILIZATION

Whenever possible the soil should be improved by the addition of organic matter, either through the use of barnyard manure or by plowing under green manures. The latter practice is increasing in Texas and throughout the Southwest.

Manure is important in growing onions on mineral soils, especially those poor in humus. If the manure is not well rotted, it should be applied to the crop preceding the onions. From 15 to 20 tons per acre is considered sufficient. On many soils manure should be supplemented with commercial fertilizers to produce the best results; where manure is not available, equally good results may be obtained with fertilizers alone. Muck or peat soils do not require additional humus; and nitrogen, phosphorus, and potash can be supplied more economically in chemical fertilizers.

The application of commercial fertilizers is usually profitable irrespective of the soil type, as the onion root system is comparatively limited and the feeding zone rather restricted. Extensive tests by

the Texas Agricultural Experiment Station on several soil types and in scattered localities in the Winter Garden and Laredo districts of south Texas indicate that fertilizer mixtures such as 6–12–0, 6–18–0, and 5–15–0 should be applied at rates ranging from 600 pounds per acre on the silt and clay loams to 1,000 pounds on the sandy loams. Higher grade fertilizer mixtures such as 16–20–0 and 11–48–0 are applied at proportionately lower rates. Some growers mix the 16–20–0 and 11–48–0 fertilizers in a 50–50 mixture to obtain a 13.5–34–0 ratio. With the exception of the 16–20–0 fertilizer, all those mentioned have a 1–2–0, a 1–3–0, or a 1–4–0 ratio or ratios approximating these. The 1–2–0 fertilizers are better adapted to heavier soils, and the 1–3–0 and 1–4–0 are better suited to the lighter soils. In other words, less phosphoric acid in proportion to nitrogen is needed on silt and clay loams than on sandy loams. Onions on sand and sandy loams usually show much more response to fertilizer applications than those on silt and clay loams.

Side dressings of 50 to 75 pounds of sulfate of ammonia per acre are commonly applied, especially in January or February. Tests indicate, however, that such side dressings are of questionable value except on certain very fine sandy loams adjacent to the Rio Grande or where the crop is showing a noticeable yellowing of foliage due to a lack of nitrogen. Side dressings, even of a balanced, fairly soluble fertilizer, do not equal in value the same material applied to the soil before the crop is set out. The most efficient method is to have equipment that will make the beds and place the fertilizer beneath the row all in one operation. This method is usually the cheapest and most satisfactory; the yield is usually heavier than where the same amount of fertilizer is applied broadcast.

In California onions are grown both on mineral and on peat soils. On most mineral soils it is necessary to add a fertilizer high in nitrogen, and on some it is necessary to add phosphate as well. A general recommendation is to apply a fertilizer containing about 100 pounds each of nitrogen and phosphoric acid per acre. This can be supplied by using 16–20 Ammo-phos at the rate of 500 to 600 pounds per acre or 1,000 pounds per acre of a 10–10–0 fertilizer. On very light soils that are leached excessively it is often desirable to side-dress with about 50 pounds of nitrogen per acre before the plants start to bulb. This can be supplied by drilling nitrate of soda or sulfate of ammonia or by applying anhydrous ammonia gas directly in the irrigation water. For transplanted onions the fertilizer should be applied 3 to 4 inches deep under the plant row or on the shoulder of the bed at the time of transplanting. For seeded onions the fertilizer may be applied on the shoulder of the bed at the time of planting or when the seedlings are several inches high. On soils subject to heavy leaching better yields are obtained when the nitrogen is derived from ammonia or organic sources rather than from nitrate sources. In tests conducted on the mineral soils it was not found necessary to add potash to the fertilizer.

On the peat soils of the Delta district it is necessary to apply a fertilizer containing phosphoric acid and potash. Usually 100 to 150 pounds of each of these elements is required. This can be supplied by adding 1,000 to 1,500 pounds per acre of a 0–10–10 fertilizer. The exact amount of phosphoric acid or potash required will depend largely upon the fertilizer practices of the previous years. Peat soils generally supply enough nitrogen so that it is not necessary to add this

element. In some places, however, nitrogen applied as a side dressing after the plants are growing might prove beneficial. The fertilizer should be drilled in several inches from the plant row and about 4 inches deep at planting time or very early in the growth of the plant. For high yields of onions it is essential to get good top growth before bulb formation begins.

In Louisiana 400 to 600 pounds of 4–12–4 fertilizer per acre is applied, well mixed in the row, 10 days to 2 weeks before transplanting. As a rule, a side dressing of nitrate of soda at the rate of 50 pounds per acre is given when plants are about the size of a lead pencil. A second application at the same rate is given about 4 weeks after the first.

PREPARATION OF THE SOIL BEFORE PLANTING

Preparation of the soil when irrigation is necessary depends upon the system of irrigation to be followed. It is about the same whether seedlings or a transplant crop is to be grown. Land should be thoroughly prepared by plowing, disking, and harrowing. If the soil is especially foul with weeds, it will often pay to irrigate the seedbed 2 or 3 weeks before planting time and then by disking or harrowing kill the crop of weeds that appears. The disking should be rather shallow to avoid bringing to the surface too much new seed-laden earth.

In many districts raised beds similar to those used for growing lettuce and carrots under irrigation in California are used for the growing of both the transplants and the bulb crop, especially on the upland mineral soils. The soil should be in a well-pulverized condition so that the beds will be free from large lumps. For small plantings the beds are usually thrown up with a lister and then shaped with a sled, but for the larger ones usually both operations are performed at one time. The beds are made 36 to 42 inches from center to center and about 4 inches high.

In certain districts of the Southwest where the border system is used, ridges 6 to 8 inches high and 150 to 300 feet long are made 5 to 12 feet apart. These are laid out on the contour of the land, as shown in figure 1, so that the entire area between the borders can be flooded uniformly.

Figure 1.—A contoured onion seedbed in Texas.

On the peat lands of the Delta district of California the land is plowed, disked, harrowed, and floated. Small irrigation or spud ditches are run through the field at intervals of 80 to 100 feet. The soil from the ditches is leveled so that the land can be planted to the edge of the ditch.

GROWING AND HANDLING TRANSPLANTS, OR SEEDLINGS

GROWING TRANSPLANTS FOR HOME USE

If an especially fertile soil can be chosen for the seedbed the use of commercial fertilizer will be unnecessary, but if a poor soil has to be used or if the seedlings grow weakly or have an unhealthy yellowish-green color, a fertilizer application is often desirable. In Texas 50 to 100 pounds per acre of an 11–48–0 mixture or 100 to 200 pounds of a 5–15–0 mixture can be used before the seed is sown. For side dressings sulfate of ammonia at the rate of 75 to 100 pounds per acre is usually satisfactory.

It is important that the seedbed be planted on soil free from infestation with the pink root fungus. Even if the disease was not observed on the previous crop, it is best to avoid land on which onions have been grown at any time during the previous 4 or 5 years. If pink root occurs in the seedbed, the disease will be carried to the field at transplanting time and the yields will be reduced.

In the production of transplants the chief object is to produce as many as are needed in as small a seedbed as is consistent with the production of healthy, vigorous, pencil-size plants. Over 112,000 plants are required for an acre when the plants are set 4 inches apart in 14-inch rows. For any spacing approximating this it is a common practice to sow 2 pounds of seed for every acre of the transplanted crop. Most growers expect to obtain enough plants from 1 acre of seedbed to set 10 acres. Seedbeds of 5 to 20 acres are not uncommon in south Texas.

In south Texas the seed of the Bermuda varieties is usually planted from September 15 to 25, whereas that of Early Grano (Babosa) and related varieties should be sown in early September. In the Collin County district of north Texas the few growers who raise their own plants usually sow the seed about October 15.

Tests reported by the Texas Agricultural Experiment Station indicate that 17 to 20 pounds of seed per acre of seedbed produces enough plants to set 10 acres with a maximum proportion of the desirable pencil-size plants. Grading plants at transplanting time may be impractical because of the time and expense involved; therefore it is important to adjust the rate of seeding so that a maximum number of medium-size plants will be produced. With heavier rates of seeding, such as 30 to 35 pounds per acre, most of the plants are too small to make good transplants. Some growers use a spreader on the seeding machine to scatter the seed over 2- or 4-inch strips. In these wide rows seeding rates can of course be higher, but unless the land is practically free from weeds such rows require much more hand labor. Rows are usually 14 to 16 inches apart.

In Louisiana the seed is usually drilled in the seedbed from October 1 to 15 in rows 4 to 6 inches apart. The seedbed may be covered with moss or other material that is kept damp until the seedlings are up. At Thibodaux, La., the seed is planted about 4 inches deep and

when it starts to germinate the excess soil is raked off. This deep planting keeps the seed in moist ground and raking off the excess soil kills the weeds.

In California the seed for the transplant crop is usually planted on raised beds in rows 2 to 8 or even 10 inches apart. On the peat soils of the Delta district rows are spaced close together on wide beds, as many as eight rows being planted on one bed. (See cover illustration.) On sedimentary soils raised beds are generally used, either two or four rows being planted on a bed (fig. 2). Occasionally seed is broadcast in open beds or hotbeds and then raked in. The date of planting depends upon the location within the State, the variety to be used, and the time it is desired to have the crop mature. Seeding is generally done between September 1 and October 1.

In the North the seed is usually sown in coldframes, greenhouses, or hotbeds 10 to 12 weeks before the plants are to be set in the field. Seed is usually sown thinly—10 to 12 seeds to the inch—in rows about 4 inches apart and about half an inch deep. Dusting the seed at time of sowing with some organic mercury compound as recommended by the manufacturer helps to prevent preemergence damping-off and usually increases the number of seedlings. Because of their susceptibility to damping-off onion seedlings are much more difficult to grow indoors than out in the open; therefore, care must be used in watering. Especially while the plants are small, watering should be avoided during cloudy weather; on bright days it should be done the first thing in the morning so that the soil surface will dry before night. After the first true leaf has appeared there is much less danger of loss from damping-off.

Figure 2.—Four rows of Stockton Yellow Globe onion seedlings growing on each bed for the intermediate crop in the lower San Joaquin Valley, Calif.

The best seedlings are produced at cool temperatures. A night temperature of 50° F. and a day temperature of 60° to 65° are satisfactory, but a slightly higher temperature during the day will do no harm on clear days. Plants should be set in the field in early spring just as soon as the soil can be worked. If the seedlings are tender, they should be hardened somewhat before they are planted in the open by watering less frequently and by exposing to night temperatures of 40° to 45° for a week to 10 days.

Southern-grown plants are now available for transplanting in most districts, and many home gardeners prefer to buy these rather than to grow their own supply.

GROWING AND HANDLING TRANSPLANTS FOR SHIPMENT

Growing onion plants for shipment is a considerable industry in south Texas, Georgia, and some of the other Southern States. Often growers specialize in this type of business to the exclusion of growing dry bulbs; others conduct both enterprises. Some growers specialize in carlot or truck shipments; others confine their activities to mail-order and express shipments. Although the individual shipments may be small, the total volume of business may be large. Growers catering to small orders often ship onion plants 8 months in the year and plant and have seedbeds 10 months. Shipments go to every State in the Union, as well as to Canada and Cuba. Peak shipments of onion plants come in late winter or early spring, when the northern demand is greatest.

The chief problem of the onion-plant grower who caters to a year-round business is to estimate the demand for the different months and to have the right number of plants available at the proper time. He must know the approximate time needed to grow a transplant at the different seasons of the year. Seed planted toward the end of September in south Texas will produce good transplants in late November or early December, while seed planted toward the end of October may not produce seedlings ready for pulling until late January or early February. Growers become adept in timing irrigations to speed up or slow down the growth rate of the seedlings so that they will be available at the right time for planting in the various districts.

As the plants are often in transit for a week or more, they must be handled so as to prevent decay. They are pulled and tied in bundles; the roots and tops are trimmed; and the plants are packed upright in dry, well-aerated, flat crates for shipment.

TRANSPLANTING

In the South and Southwest the plants are usually ready to be set 8 to 10 weeks after seeding. Early Grano often grows somewhat faster than the Bermuda varieties and therefore reaches transplanting size somewhat sooner. In Texas transplanting is usually done during November and December, but it may extend into early January or even later. Early plantings of medium-size plants usually produce heavier crops than late plantings, other conditions being equal.

Healthy vigorous seedlings about one-fourth to five-sixteenths inch in diameter at the neck and about 7 to 13 inches in height before pruning are best for transplanting. The seedlings may be plowed

out, but a common procedure is to irrigate the seedbed in advance so that they can be easily lifted without plowing. When a worker has accumulated a handful of plants, he removes part of the tops by a quick twist of the hand. If the roots are long they also are trimmed by shears, whole bunches being clipped at one time. The pruned seedlings are about 5 to 6 inches long. Experiments conducted in Texas and California show, however, that a considerable reduction in yield of bulbs occurs when both tops and roots are pruned. The only advantage is that pruning facilitates transplanting.

Very small plants should be discarded, as both the Texas and the California Agricultural Experiment Stations have shown that they are consistently less productive than medium-size plants. Large plants produce higher total yields than either small or medium-size ones; but the marketable yields may be reduced by the presence of a large proportion of splits, doubles, and bolters—all cull grades.

In Texas the seedlings are pulled, pruned, and placed in baskets or crates; then they are distributed ahead of the planter along three rows at a time, as shown in figure 3. All transplanting is done by hand. A short stick or dibble is used by most workers to make a hole and to press the soil around the plant. Experienced planters can scatter and set as much as one-third acre (37,000 plants) a day, but the average planter usually sets about one-fifth to one-fourth acre. Most of the planting is done by contract, the workers being paid by the number of acre rows (rows 210 feet long) set.

To facilitate irrigation on the uplands in Texas, low ridges are usually made 14 to 20 inches apart; the seedlings are planted one row to a ridge. The rows are marked by various means to facilitate uniform spacing. One method is to use a lightweight metal or wooden roller having slats 3½ to 4 inches apart, the distance apart the plants

Figure 3.—Transplanting onions in Texas, where three rows are set at a time. Seedlings are scattered ahead of the planter.

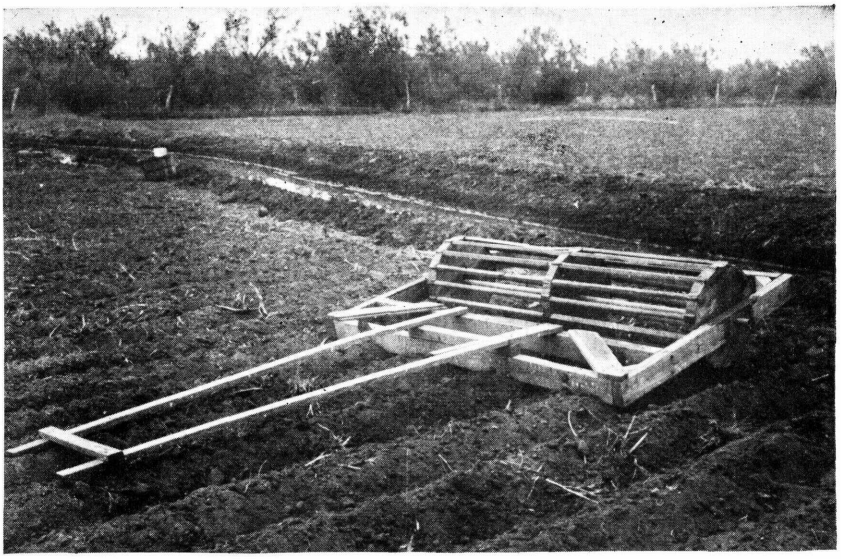

Figure 4.—Lightweight slatted roller, which leaves slight indentations 3½ to 4 inches apart to indicate places in which plants are to be set.

are to be set in the row (fig. 4). On the bottom lands, where the onions are grown in flat beds, or "melgas," between raised borders, very shallow furrows are made about a foot apart to mark the rows.

In California the seedlings are transplanted in late November, December and January. By the use of a small plow a furrow slice is thrown away from each side of the raised bed at the top. The seedlings are laid against the side of the furrow, about 3 inches apart and at an angle of about 45°, with the tops toward the center of the bed. The roots are then covered, a lister or cultivator being used; and, if necessary, water is run between the beds to settle the soil around the roots. The plants are set so that the rows will be 8 to 10 inches apart on the bed (fig. 5) and a uniform distance apart to facilitate cultivation. In the Coachella Valley of California onions are grown in single rows on low ridges (fig. 6).

On the peat soils of the California Delta district the intermediate crop is set on the level. The rows are spaced about 10 inches apart, and the plants are set 3 inches apart in the row. A hand cultivator with two plows attached is used for planting (fig. 7). The right plow covers the plants that have just been set while the left one opens the furrow for the next row. Here, too, the seedlings are laid against the side of the furrow in a slanting position (fig. 8), but they gradually grow erect so that there is no interference with cultivation. As the soil is usually moist during the transplanting season there is no need for irrigation.

When seedlings have reached the proper size they should, as a rule, be transplanted. Experiments with the intermediate crop in California show that yields from early plantings are the heaviest and that in general as the transplanting date is delayed the yields are smaller. Generally, seedlings make very little growth above ground during the winter in central California, southern Nevada, southern Utah, and other places with a similar climate, but conditions are

Figure 5.—Seedlings planted two rows on a bed, the system generally used in California for the transplant crop on mineral soils.

Figure 6.—Growing onions in single rows on low ridges in Coachella Valley, Calif.

Figure 7.—Transplanted onion seedlings on peat land in the Delta district of California. The right plow of the cultivator covers the seedlings that have just been set, and the left plow opens a new furrow. The seedlings in the box show the method of pruning generally used.

usually favorable for root development. Plants set early develop extensive root systems during the winter, so that they grow rapidly when the weather becomes warm in early spring. Onion plants start to bulb under conditions of temperature and length of day specific

Figure 8.—Transplanted onion seedlings on peat land in the Delta district of California. Seedlings are laid in a slanting position against the side of the furrow and then covered.

Figure 9.—Transplanting Red Creole onions on raised beds, Pointe Coupee Parish, La. (Courtesy G. L. Tiebout.)

for the variety. Usually when environmental conditions become favorable for bulbing, the larger plants will produce the larger bulbs. Therefore, conditions that help to produce large plants also help to increase the size of the bulbs and consequently the yield per acre.

In Louisiana plants are set in the field between December 20 and January 15. They are set about 4 inches apart in single rows on raised beds which are about 3½ feet apart (fig. 9). Raised beds are used to provide drainage (fig. 10). In the center of the ridge, holes are

Figure 10.—Red Creole onions growing on raised beds, which provide drainage, in southern Louisiana. (Courtesy G. L. Tiebout.)

made, into which the seedlings are dropped; then the soil is firmed about them.

IRRIGATION

The frequency and amount of irrigation required depend on so many variable factors, such as type of soil, amount of rainfall, condition of crop, variety, and presence of thrips and diseases, that it is difficult to give definite recommendations. Most of these factors vary from year to year and from farm to farm. If the soil is dry, onions should be irrigated as soon as possible after they have been set, as shown in figure 11. Many growers delay this operation too long; some delay it intentionally, with the idea that such procedure is beneficial. Although onion seedlings will survive 12 days or more after being transplanted to a very dry soil, experiments have shown that such practice always results in lower yields. Roots continue to arise from the stem plate at the base of the onion plant during most of the time that the plants are growing. Because new roots are not formed unless the zone from which they arise is in moist earth, the soil near the surface must be kept moist until the crop is nearly mature.

Most of the transplant crop of the Southwest and West is irrigated during part or all of the growing season. Onions must be kept growing steadily without any set-backs, as those which start new growth after being retarded may split or double and thus produce a smaller yield of U. S. No. 1 bulbs.

On the sandy loams of southwest Texas five to eight irrigations are usually all that are required between transplanting and harvest. More may be needed during seasons of heavy thrips infestation. From December to early March irrigations can be 6 to 10 weeks apart, but beginning in March the frequency must usually be increased to once every 5 to 14 days. In south Texas the especially strong winds prevalent at this time increase the water requirement.

Overirrigation, as well as lack of water, may cause reduction in yields. The foliage of onions receiving excessive irrigation acquires a somewhat unhealthy yellowish-green color. This may be difficult to observe in a year of severe thrips infestation, but if the soil rarely gets dry it probably has been overirrigated. Tests have shown that onions that receive just enough water will often yield as well as or better than those growing in soil that is continuously moist or wet on the surface. On the other hand, it is difficult to determine when a soil has been receiving too little irrigation, as the crop may appear healthy and vigorous.

On the peat lands of the California Delta district the surface of the onion land is usually below that of the water in the streams, and irrigation is carried on by siphoning and pumping the water from the rivers and network of waterways that surround the islands into large ditches that carry it to a system of laterals extending through the fields. The soil is open and porous, and when the water is raised in the ditches the water table is elevated throughout the entire soil area. The water is raised to within a few inches of the surface and is then pumped back into the river until the water level reaches the desired depth.

When the plants start to mature, irrigation should be discontinued and the soil allowed to dry out as much as possible; otherwise a second root growth, which is difficult to stop, may start and complicate the process of properly curing the onions.

Figure 11.—Irrigation water run between rows of onions just planted on dry soil.

CULTIVATION AND WEEDING BY BURNING AND SPRAYING

CULTIVATION

Weed control is essential both in the seedbed and in the field, as onions must be kept free from weeds to produce maximum crops. All cultivations should be shallow, as the small feeder roots of onion plants are near the surface. The crop is usually cultivated after a heavy rain and in irrigated districts after each irrigation. This controls weeds, prevents crusting of the soil, and facilitates the penetration of water at the next irrigation. Need of additional cultivations depends on the growth of weeds between irrigations or rains. Cultivation should be discontinued if too much injury to the tops occurs.

Light tractors with attached cultivator equipment are commonly used to cultivate several rows simultaneously. As a rule, cultivation must be supplemented by hand weeding both in the seedbed and in the field, as shown in figure 12; this essential operation is slow and tedious. In Texas weeding is often done by contract at so much an acre, the price depending on the condition of the field. When an agreement has been reached, the contractor hires a sufficient number of workers and does the job as quickly as possible.

USE OF CHEMICAL SPRAYS AND BURNING TO CONTROL WEEDS

The control of weeds represents one of the major costs of growing a crop of onions. The general practice in most districts for both plant beds and fields is to remove weeds by cultivation and hand hoeing. In the last few years, however, much effort has been expended in developing methods to reduce the costly hand weeding of onions. It is now possible, at least in some districts, by using proper precautions to grow the transplant onion crop with little or no cultivation and hand weeding.

The control of weeds in the nursery or plant bed is the grower's first consideration. Generally the first weeds are from seeds which germinate more rapidly than those of onion and appear before the onion plants emerge. These weeds may be killed by a preemergence oil spray with either Diesel oil or stove-top oil. Diesel oil is preferred because it is more effective on small grasses.

Forty or fifty gallons per acre is sufficient to give complete coverage if the spray equipment is properly used. This can be done by using nozzles of small aperture, speeding up the spray machines, and reducing the working pressure to 75 to 100 pounds. A preemergence oil spray should not exceed 75 gallons per acre.

A preemergence oil spray should be applied before the onion plants emerge; otherwise the onions, as well as the weeds, will be killed.

An alternative method of controlling the first weeds in the seedbed is to burn off the top of the beds. This allows a few days' delay in treatment. Special burners utilizing butane or other suitable fuel have been constructed on sleds that are dragged over the plant beds. Burning may be delayed until the onion cotyledons appear above the soil. This allows time for more weed seeds to germinate. The onion cotyledons, as well as the weeds, are burned to the ground. The onions will send up new leaves from below ground, but the weeds will be killed.

Burning should be done before the first true leaf of the onion appears.

Weeds can be successfully controlled in the plant beds after the plants have passed the seedling stage or in the transplanted field by use of a selective spray. The usual material is a salt of dinitrophenol such as Sinox W or Dow Selective. Both of these proprietary spray mixtures are available at supply stores. These sprays will kill most broadleaved weeds, but they are not effective on grasses. Sinox (sodium dinitro-ortho-cresylate) is also used to control weeds in onions.

Figure 12.—Weeding onions with small hand hoes in Texas.

Three to four quarts of one of these materials is generally mixed with 100 gallons of water and applied at the rate of 100 gallons per acre. State experiment stations or other agencies recommend slight variations in spray concentration that seem more suitable for local conditions. In many districts commercial spray companies familiar with local recommendations and possessing all necessary spray equipment may be engaged to do the spraying.

Onion fields are sometimes sprayed more than once, the frequency depending on the number of weeds present or that grow after the first spray. However, when the onion tops have enlarged and spread, the sprays may cause some burning of the tops of the leaves.

Selective sprays should be used with considerable caution.

In areas where rain never or seldom falls during the growing season selective sprays are comparatively safe. However, rain a few days after spraying may result in the loss of a large percentage of the plants. Onions growing on peat or light sandy soils are particularly susceptible to injury. Overhead irrigation should not be used until several weeks after spraying. High temperatures at time of spraying may result in some injury to the onions.

A new selective chemical (potassium cyanate) for controlling weeds in onions has recently been made available in experimental quantities. A 1-percent solution (1 pound to 12 gallons of water) is recommended for young onions and a 2-percent solution for onions 6 inches high or higher. Enough solution to wet the weeds, usually 50 to 80 gallons per acre, is used. This new chemical looks very promising.

BOLTING

In practically all the districts where the transplant crop is overwintered a high percentage of the plants may bolt; that is, they may produce seedstalks. As a rule, these plants are not marketable and therefore represent a loss. The amount of bolting is determined by the interaction of a number of different factors. Certain varieties tend to bolt much more readily than others. Sweet Spanish, White Sweet Spanish, Crystal Wax, Yellow Bermuda, Excel, White Creole, and Red Creole bolt rather readily; Red 21 (California Early Red), Calred, Stockton G36, Stockton Yellow Globe, Early Grano, Texas Early Grano, San Joaquin, Italian Red, and California Hybrid Red No. 1 do not bolt so readily. The size of the overwintered plant also plays a very important part, as large seedlings bolt much more readily than small ones.

Temperature, as well as the variety and the size of the overwintered plant, is important in determining the amount of bolting. The highest percentage of bolting occurs after a warm late fall and a cold late spring. A warm fall favors the development of a large plant for overwintering, and the combination of a large plant and a cool spring provides ideal conditions for bolting. Conversely, the fewest bolters occur after a cool fall and a warm spring. The effect of a difference of a few degrees in temperature on bolting is often evident in commercial fields. In districts where two rows of transplants are grown on raised beds running east and west, the north row frequently has more bolters than the south. The north side of the bed is cooler because it does not get the direct rays of the sun and in addition is shaded by the south row. More bolting occurs on heavy than on light soils,

and usually there are more bolters in low spots in the field that remain moist than in well-drained parts. In south Texas a few days' delay in time of seeding in the nursery or in transplanting will often reduce considerably the amount of bolting.

HARVESTING AND CURING

The market price, the condition of the crop, the weather, and the inclination of the grower all help to determine the actual date when harvesting of onions is to begin. In general, growers start to harvest when 30 to 50 percent of the tops have fallen over. In most districts the tendency is to pull the crop when the bulbs have reached about their maximum size but while the tops are still green. Most commercial growers do not wait for the crop to mature fully. Studies in Texas and California, however, show that yields continue to increase until most of the tops have fallen over or at least have softened at the neck. Bulbs harvested when somewhat immature retain their outer scales longer and therefore keep better during the short time that they may be held in storage.

If necessary the onions can be plowed out to facilitate harvesting. When four, six, or more rows are marked at a time in planting, they can be plowed simultaneously at harvest by adjusting the same equipment. To cut the roots of onions grown on raised beds, some growers use a subsurface knife fastened horizontally between two boards and pulled by a team or a tractor. Roots are cut several inches below the bulb. If the onions are somewhat immature, they can be left standing in the row and allowed to ripen for a week or two. This system works particularly well with the Early Grano variety, which because of its heavy foliage usually ripens more slowly than the Bermudas. The last irrigation, however, often leaves the soil sufficiently soft for the onions to be pulled without being plowed.

As the onions are pulled they may be thrown into windrows and allowed to cure, or the tops and roots may be clipped off immediately and the bulbs placed in crates, baskets, or other containers (figs. 13 and 14). The length of curing depends on the maturity of the crop and the atmospheric conditions. If the onions are fairly mature, the

Figure 13.—Onions being cured in crates stacked in the field. Onion tops are placed on the top crate to prevent sunscald.

Figure 14.—Early Grano onions being cured in baskets in the field, Batesville, Tex. (Courtesy W. B. Cook.)

humidity low, and the air movement good, it is not unusual to pull, clip, and ship the same day. If the crop is windrowed in hot, sunny weather, the bulbs should be protected by overlapping tops to prevent sunscald. The tops are clipped to leave a short neck; cutting too close to the bulb is undesirable (fig. 15), as a large open wound does not dry well and decay organisms may enter. The roots are trimmed close to the base of the bulb.

Harvesting, like planting, is usually done on contract, the workers receiving a fixed amount per bushel pulled, clipped, or hauled, as the case may be. The crew that sorts the bulbs into the various sizes and grades usually works by the hour or day.

GRADING AND LOADING

In south Texas the cured onions are usually hauled to central packing sheds, where they are run over graders to sort out the jumbos and those of small size. Most of the crop is sold in open-mesh 50-pound sacks. These provide good aeration and make an attractive package. Refrigeration cars are used for shipping. Usually 510 50-pound sacks are loaded in a car (fig. 16).

When Bermudas are sold to truckers directly from the field, they are often not run over the grader but are given a so-called polishing. This consists in dumping a bushel of onions onto a burlap sheet. This sheet is then lifted from the ground by two laborers who hold the corners. By raising and lowering opposite sides of the burlap, the onions are rolled back and forth to loosen the scales and rub off the soil.

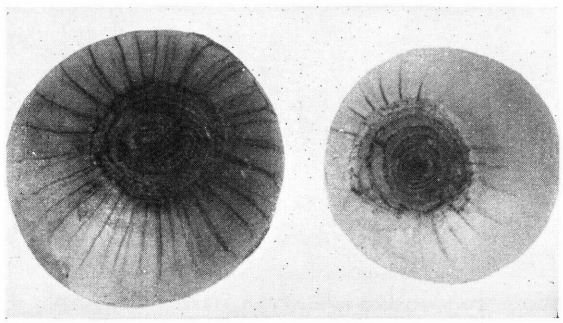

Figure 15.—Bulbs clipped too close.

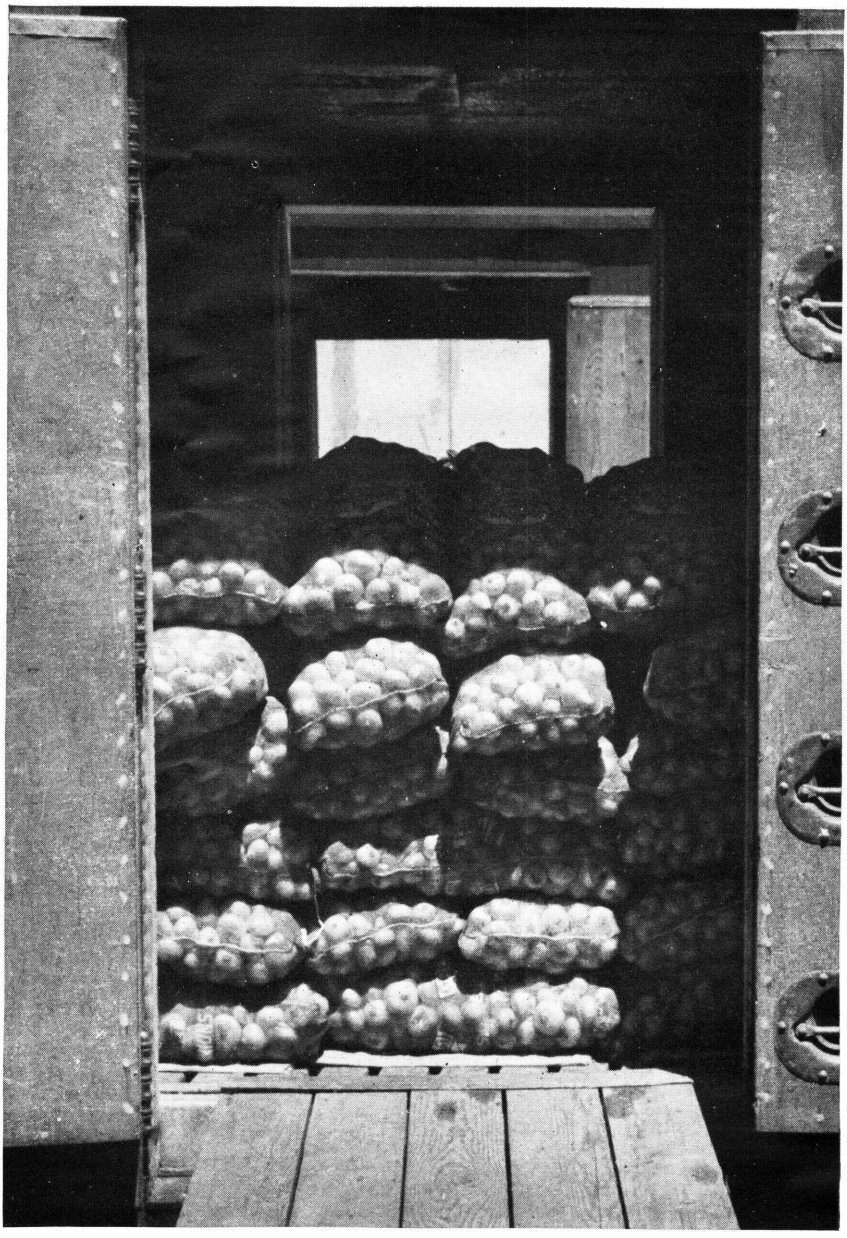

Figure 16.—Excel onions in 50-pound open-mesh bags, loaded for shipment, Laredo, Tex.

VARIETAL DESCRIPTIONS

All the onion varieties described herein can be used as transplants. The descriptions in general follow closely those in Miscellaneous Publication 435, Descriptions of Types of Principal American Varieties of Onions.

Yellow Bermuda.—This variety is adapted to the South and the Southwest, where it is grown as a winter crop. In south Texas and California when it is seeded in mid-September and the seedlings are transplanted to the field in November or December, the bulbs usually mature in April and May. It is not adapted to the Northern States when seeded in the field; but, when it is seeded in the greenhouse in December or January and the plants are set in the field in early spring, the bulbs mature in June, July, or later, depending on the district. Seedlings are grown extensively in the South for shipping north for planting in home and market gardens. The bulbs attain a diameter of 3 to 3½ inches when grown under irrigation in the South and Southwest; they are flat and have very few thin, shiny, pale-yellow scales that are soon broken and lost in handling. The flesh is soft and very mild in flavor.

Excel.—This variety is a single-plant selection from Yellow Bermuda developed and introduced in 1945 cooperatively by the United States Department of Agriculture and the Texas and California Agricultural Experiment Stations. It is adapted to the South and Southwest, where it is grown as a winter crop. In most plant characteristics it is similar to Yellow Bermuda. Excel does not bolt so readily as Yellow Bermuda when they are planted at the same time. It is somewhat resistant to pink root. The bulbs mature about 10 to 14 days earlier than those of Yellow Bermuda. Because of the early-maturing habit the bulbs do not reach sufficient size in the North, and therefore the variety cannot be recommended for the transplant crop there. The bulbs are a little thicker than those of Yellow Bermuda, free of pink flesh, and practically free of doubles and splits. The Excel variety should be harvested a little on the green side and precaution taken to avoid sunscald. In the Rio Grande Valley it outyields Yellow Bermuda. The flesh is crisp and mild in flavor; these qualities make it a good salad onion.

Crystal Wax.—This variety is adapted to the South and Southwest, where it is grown as a winter crop. In south Texas and in California when seed is sown in mid-September and the seedlings are transplanted to the fields in November and December, the bulbs usually mature in April and May. Crystal Wax is not adapted to the Northern Sttaes when grown from seed in the field; but, when it is seeded in the greenhouse in December or January and the plants are set in the field in early spring, maturity is reached in June, July, or later, depending on the district. Crystal Wax bolts rather readily. Seedlings are grown in the South for shipping and planting in the North. Crystal Wax is also grown extensively as a green bunch onion. When grown under irrigation in the South and Southwest, the majority of the bulbs attain a diameter of 3 to 3½ inches. The bulbs are flat and have very thin, shiny, dry, white scales that are soon broken and lost in handling. The flesh is soft and very mild in flavor.

Early Grano (Babosa).—This variety, introduced by the New Mexico Agricultural Experiment Station, is adapted to the South and Southwest, where it is grown as a winter crop, and to the North, where plants are set in early spring. It is adapted to the same areas as Yellow Bermuda. It is somewhat resistant to damage by thrips, but very susceptible to injury by the pink root fungus. Early Grano bolts much less readily than Yellow Bermuda and Crystal Wax in Texas when planted at the same time, and it is a heavier yielder. Under irrigation in Texas and in the Southwest the bulbs mature at the same time as those of Yellow Bermuda and reach a diameter of 2½ to 3 inches. The bulbs are round to top-shaped and have very few thin to medium-thick, pale-yellow scales that are soon broken and lost in handling. The flesh is soft and very mild in flavor.

Texas Early Grano.—This variety was developed and introduced by the Texas Agricultural Experiment Station. It was developed by selecting early-maturing bulbs in a field of commercial Early Grano near Winter Haven, Tex. It is adapted to the South and Southwest, where it is grown as a winter crop. In general, its characteristics are similar to those of Early Grano except that it is more uniform and earlier maturing. It bolts less readily than Yellow Bermuda and is somewhat resistant to thrips, but very susceptible to pink root. It is a heavy yielder.

Red Creole.—Red Creole seems to be fairly well adapted to the southernmost districts of the Southeast and along the coast as far north as Charleston, S. C. In the North bulbs seldom exceed 1 inch in diameter; therefore, Red Creole is not adapted for use there. At present it is of commercial importance only in southern Louisiana, where it is the chief variety for home and market purposes, as it keeps better in open sheds or barns during the humid summer than any

other variety. In southern Louisiana the bulbs reach a diameter of 2 to 2½ inches. They are flat to medium oblate in general shape. The upper half is slightly rounded to slightly tapered; the lower half is flat to slightly rounded. The outer dry scales are retained fairly well in handling and storage. They are dull buff red on the lower half, with more buff in the veins and on the upper half toward the neck; dry scales become more dull and more buff with age. The bulbs have a high dry-matter content and are very pungent and firm in texture.

White Creole.—Same as Red Creole except for being white.

Stockton Yellow Globe.—This variety is the one grown most extensively at present for the intermediate crop in central California. It is a heavy-yielding yellow onion mild in flavor. The shape is somewhat variable but mostly high flat to globe.

Stockton G36.—This is a strain of Stockton Yellow Globe introduced by the California Agricultural Experiment Station. It is especially well adapted for the intermediate crop in the central coastal district of California. It is highly nonbolting. The bulbs mature 10 to 14 days later than those of Red 21. They are yellow, slightly conical, with the top somewhat flattened, and mild in flavor.

Red 21 (California Early Red).—This variety, developed from California Early Red, was introduced by the California Agricultural Experiment Station. It is grown chiefly for the intermediate crop in central California, where the bulbs attain very large size, the majority being 3 to 3½ inches in diameter. They are uniform in size, shape, color, and time of maturity, and flat to medium oblate in general shape. The scale color is red, and the flesh is pink. The degree of color varies somewhat with the district, being much more intense when the onions are grown and matured under low temperatures than when they are grown under high temperatures. The flesh is soft and very mild and sweet in flavor.

Calred.—This variety was developed and introduced cooperatively by the California Agricultural Experiment Station and the United States Department of Agriculture. It is an intermediate variety, the bulbs maturing at about the same time as those of Early Grano. It is adapted to the same production areas as Early Grano. It is highly nonbolting. The seedstalks are highly resistant and the foliage is moderately resistant to the race of onion downy mildew present in central California. The bulbs are deep flat and almost black red, with outer scales a little lighter in color. The flavor is mild.

Italian Red.—This variety is very productive and is adapted to central California as a late-intermediate crop for immediate local consumption. It is not adapted to the Southern States because of the long daylight required for bulb formation or to the humid areas because of its extreme susceptibility to various bulb rots. Italian Red is highly nonbolting. In central California, when the seed is sown in late August or early September and the seedlings are set in the field in November or December, the bulbs usually mature in late July. As most of the bulb forms above the soil level, Italian Red can be grown on heavier soil types than other varieties. The mature bulbs are torpedo- or long-oval-shaped and may reach a diameter of 2½ to 3 inches. The medium-thick, purplish-red, dry scales are soon broken and lost in handling. Of the varieties described in this bulletin, Italian Red has the shortest storage life. It is highly esteemed for salad and garnish purposes, because of its attractive color and very mild and sweet flavor.

California Hybrid Red No. 1.—This variety was developed and introduced cooperatively by the California Agricultural Experiment Station and the United States Department of Agriculture. It is a true F_1 hybrid produced by crossing Italian Red and Lord Howe Island. This variety is especially adapted to central California when it is grown as an intermediate crop. It is an early-maturing red globe onion. It is a very heavy yielder and popular as a home-garden sort. The flavor is mild and sweet.

San Joaquin.—This variety was developed and introduced cooperatively by the California Agricultural Experiment Station and the United States Department of Agriculture. Tests to date show that it grows well in Riverside County and in the San Joaquin Valley of California, in southern Utah, and in eastern Virginia. It is highly nonbolting. The bulbs mature at about the same time as those of Crystal Wax. It is a large yellow globe onion. The flesh is mild in flavor.

Sweet Spanish.—This variety is best adapted to the Mountain States and California, where the crop can be grown under irrigation and under fairly dry atmospheric conditions. It also does well as a transplant crop in the North when seed is sown in the greenhouse in late December or in January or when southern-grown plants are used. Being a late-maturing variety, it is usually harvested in the North in late August or early September. It is somewhat resistant to thrips. The yellow bulbs are globe-shaped but vary from deep oblate to slightly oval and attain a diameter of 3 to 3½ inches. Because of its succulent, sweet, mild-flavored, almost white flesh it is greatly esteemed in salads.

White Sweet Spanish.—This variety is similar to Sweet Spanish except that it has an attractive white color. It is grown to some extent in the North as a transplant crop from seed started in the greenhouse and from transplants grown in the South.

VARIETAL ADAPTATION

Most varieties of onions are limited in their range of adaptation. A variety may do well in one district and be worthless in another. It is essential therefore for the grower to have a knowledge of the different varieties so that he can choose those best suited to his particular conditions. New varieties should be tested on a rather limited scale until they have been shown definitely to be adapted to the district.

The varieties grown in the United States for transplant purposes differ in size, shape, color of bulb, bolting habit, pungency, keeping quality, time of maturity, and tolerance to diseases, insects, sunscald, and high and low temperatures. No one variety is suited to all conditions and suitable for all purposes. The adaptation of varieties to certain districts is determined largely by the conditions which affect bulbing, chiefly temperature and length of day. The number of hours of daylight necessary to cause bulbing varies with the different varieties, but it is affected by temperature. At favorable lengths of day, temperatures below 60° F. may inhibit bulb formation, whereas temperatures above 70° accelerate it. The attainment of maturity requires a longer day than does the start of bulb formation. In other words, a certain day length may cause a variety to start bulbing, but a still longer day is required for the bulb to develop and mature properly. Other factors are the size and the age of the plant when temperature and day length are right for bulbing. Late planting somewhat delays the date of maturity. If seed and transplants are planted at the same time, the latter will mature first. Also bulbs in thick plantings mature more quickly than those in thin plantings. Any increase in temperature or length of day will hasten maturity. Because of the lower temperatures plants grown at high altitudes mature later than those at lower altitudes.

At Winter Haven, Tex., only those varieties that mature their bulbs by April 15 to May 15, such as Crystal Wax, Yellow Bermuda, Excel, Early Grano, and Texas Early Grano, make acceptable commercial crops. The late-maturing varieties of onions usually do poorly in the South. They may start to form bulbs, but the necks remain thick and never ripen properly. The length of day for initiation of bulbing of certain storage types is reached about April 20 at Winter Haven; for other varieties the daylight is never long enough. By April 20, however, temperatures are high and pink root and thrips abundant, so that continued increase in size is impossible. The early-maturing varieties escape the detrimental effects of high temperature and the most severe damage from thrips and pink root.

In the North it is almost impossible to obtain good yields of the extra-early varieties, such as Yellow Bermuda and Early Grano, by sowing seed directly in the field, because seeding is usually done at a date when the length of day is so long that the bulbing of these varieties is very rapid. After a few weeks temperatures are also high enough for rapid bulbing; consequently, the plants develop only a few leaves and small bulbs. To obtain large bulbs of the extra-early varieties in the North, it is necessary to set well-developed transplants in the field as early in the spring as possible so that a large plant will develop before bulbing starts.

The Red Creole variety does not seem to be able to form bulbs of commercial size in the North even when large seedlings are transplanted to the field in early spring. A striking example of poor adaptation is shown in figure 17. The rows that appear vacant in the center were planted with Red Creole transplants on March 31 in peat soil in the Delta district of central California. At that time the length of day and temperature were right for the bulbing of this variety; consequently, no new foliage was developed. Bulbing started very soon after transplanting, and the plants matured when the bulbs were about half an inch in diameter. The rows on either side of the Red Creole were of storage varieties.

In central California a considerable acreage of the so-called intermediate crop of onions is grown. Seed is usually sown in field beds in late August or early September, and the seedlings are transplanted

Figure 17.—A striking example of poor varietal adaptation in the Delta district of California. Vacant rows in center were set with Red Creole plants on March 31, when both temperature and length of day were right for them to form bulbs.

in late November and in December. During the winter and early spring the plants usually make a large vegetative development, but bulbing does not begin until the temperature and length of day are right. If the early varieties of the South or the late storage types of the North are used, they make good vegetative growth, but in the spring many of the plants form seedstalks instead of bulbs. Therefore, varieties such as Stockton Yellow Globe, Red 21, and Italian Red, which do not have a tendency to bolt readily, must be used.

Not only is it important to use varieties that are adapted to the district, but for best results it is essential that good strains of the respective varieties be obtained. It is not uncommon for a grower to lose practically his entire crop when seed of poor quality is planted (fig. 18).

Figure 18.—A field of Crystal Wax onions in Texas with a very high percentage of bolters. This field, which was practically a total loss to the grower, is an example of what is likely to happen when seed of poor quality is planted.

STORAGE

The varieties used for the transplant crop, with the exception of Red Creole, do not keep well in storage; growers, therefore, usually dispose of the crop shortly after harvest. For home consumption, however, it is often necessary to store bulbs for several weeks. They should be well cured so that the neck tissue is thoroughly dry. The bulbs should then be placed in well-aerated containers such as crates or open-mesh bags and stored in dry rooms that have a good circulation of air. The storage life of most varieties can be prolonged considerably by placing them in cold storage at 32° F. According to storage tests of the United States Department of Agriculture and a number of cooperating States, Italian Red is a very poor storage onion; Red 21 (California Early Red), Crystal Wax, Yellow Bermuda, and Early Grano are poor; White Sweet Spanish and Sweet Spanish are fair; and Red Creole and White Creole are very good.

DISEASES AND INSECTS

Diseases and insects are not such a factor in growing the transplant onion crop as in growing onions from seed. Diseases are discussed in Farmers' Bulletin 1060, Onion Diseases and Their Control. Only pink root and thrips need particular discussion in this bulletin.

PINK ROOT

Pink root[2] is probably the most prevalent and most destructive disease found throughout the South and West where the transplant crop is grown commercially.

Pink root symptoms are rather easy to identify. As the name indicates, the roots are the organs chiefly attacked; these shrivel and die and take on a distinctly pinkish color. Symptoms may appear on the roots of the very young seedlings; and, as the plant develops and sends out new roots, they in turn become diseased and functionless. As a rule, the plants are not killed by the disease, but when the root system is severely injured bulbs may not form or may remain small and yields are greatly reduced. The tips of the leaves often wither and die, making them susceptible to various fungus leaf blights.

Injury increases on succeeding crops of onions, and damage becomes more and more pronounced. During the cool winter months damage is usually not severe, but as the temperature becomes higher in the spring the causal fungus becomes increasingly active.

The control of pink root is a very difficult problem once the soil becomes infested. The only practical control is to use a long rotation. Other crops should be planted for a period of 3 years or longer.

If possible, the seedbed should be located on soil free of infestation with the pink root fungus, preferably on land that has not grown onions previously. This is a very important consideration, as seedlings with diseased roots will inoculate the soil wherever they are planted.

So far as known, none of the present onion varieties are immune from pink root. Certain varieties, however, are much more susceptible than others and should not be planted on infested soil. Early Grano is especially susceptible. Yellow Bermuda, on the other hand, is somewhat resistant but suffers severely on badly infested soil.

THRIPS

Thrips[3] are the most destructive insects on the transplant onion crop. The amount of damage varies from season to season, but some injury occurs practically every year in many districts. In the South thrips live on the onion crop throughout the winter. In the North onion thrips pass the winter on bulbs in storage, on onion plants which survive in the field, on such hardy plants as alfalfa and red clover, and in grass sod.

The female lays her small whitish eggs in the tissue of the onion leaf. Under high-temperature conditions the eggs hatch in about 5 days; under cool conditions it takes somewhat longer. The small white larvae feed on the center leaves, where the tissue is tender and they are

[2] Caused by the soil-inhabiting fungus *Pyrenochaeta terrestris* (Hansen) Gorenz, Walker, and Larson, formerly called *Phoma terrestris* Hansen.

[3] *Thrips tabaci* Lind.

well protected. In about 5 days the larvae attain full size, leave the plants, and drop to the soil, where pupation occurs. The pupal stage lasts about 4 days under warm temperature conditions and somewhat longer under cool. Thus, a complete generation extends over about 2 weeks, depending upon the temperature. If the growing season is warm more generations will occur than if the season is cool.

Environmental conditions during certain seasons may hold thrips damage to a minimum. Cool weather reduces the number of generations; hard, driving rains wash the thrips from the plants and destroy many of them; and predatory insects also aid in reducing infestations.

Onion thrips can now be effectively controlled by the use of the new organic insecticide DDT (dichlorodiphenyltrichloroethane), which can be used either as a spray or as a dust. DDT is available on the market in the form of emulsions and wettable powders to be used as sprays and in the form of powders to be applied as dusts. The emulsions and wettable powders should be used in sprays at the strength recommended by the manufacturer since the quantity of DDT contained in these preparations varies in different brands. The most effective spray formula for onion thrips control, whether made from a wettable powder or an emulsion, is 1 pound of actual DDT to 100 gallons of water. The dusts should be used at a strength of 5 to 10 percent of DDT.

DDT is poisonous to human beings and animals. Store it in a plainly marked container where children and pets cannot reach it. Do not inhale the spray or dust or let oil solution come in prolonged contact with the body.

DDT should be applied early in the season. Control is difficult after thrips have deposited numerous eggs in the tissue at the base of the leaves and larvae are protected by the closely appressed leaf bases. A second application 5 to 7 days after the first will reduce the number of newly hatched larvae, as well as of adults. Subsequent applications should be made before thrips have again increased to 10 per plant.

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